Brodie Esquire 12
with every sentiment
of respect from
the Lecturers
Birm School of
Medi

ESSAYS,

I.—ON THE

ANATOMY, PHYSIOLOGY, AND PATHOLOGY

OF

THE GREAT SYMPATHETIC NERVE,

BY MR. JAMES WILKES;

II.—ON

THE ANATOMY

OF

INGUINAL HERNIA,

BY

MR. WILLIAM HAMMOND.

To which were adjudged the Prizes of the Birmingham School of Medicine and Surgery, for the Year 1832.

ΠΙΔΑΚΟΣ ΕΞ ΙΕΡΗΣ ΟΛΙΓΗ ΛΙΒΑΣ.

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AN ESSAY

ON THE

ANATOMY, PHYSIOLOGY, AND PATHOLOGY

OF THE

GREAT SYMPATHETIC NERVE.

Qui studet optatam cursu contingere metam
Multa tulit fecitque puer, sudavit et alsit.

HOR. DE ART POETICA, L. 412.

PREFACE.

The School of Medicine and Surgery of Birmingham felicitates itself on this fifth celebration of its anniversary, that it has the power to present, after some delay, to the public such respectable specimens of the first-fruits of its *own labours*, and such honorable proofs of the diligence and scientific and literary attainments of its Students as this little volume contains.

It has been the practice of the Teachers of the School, nearly from its first institution, to give Prizes to those of the Students who, on due examination, distinguished themselves either for their knowledge or their diligence: thus exciting generous emulation, and giving that spur to enterprize which is sure to raise the clear spirit to excellence.

They have not been without their reward. This School has already sent forth professional characters, eminently useful in the several districts in which they have settled; and the education it is capable of affording, is the best pledge of future promise, and the best ground of security to the public. The claims of the School indeed, have been such, that they have called forth patronage, not only from those who are always ready when good is to be done, and science to be advanced, but even from the most distant quarters: and it is to this spirit that we owe the two Essays which are now offered to the medical Profession. The first of them, that on The Anatomy, Physiology, and Pathology of the Great Sympathetic Nerve, was endowed with a prize of ten guineas, by Edward Johnstone, M. D., the venerable President of the School, and was awarded to Mr. James Wilkes by those excellent judges, Dr. Pearson, Dr.

Eccles, and Mr. W. S. Cox; the second, on The Anatomy of Inguinal Hernia, by Mr. William Hammond, was endowed with a prize of five guineas, by E. T. Cox, Esq., and was adjudged to this Essay by that illustrious Surgeon, Sir A. Cooper, Bart.

We owe it to Mr. Hammond to state that he was also a competitor for the Johnstonian prize, but declined submitting to the division of that prize into two parts.

On the merits of these Essays we shall make no observation—Let them plead their own cause. Be it remembered, nevertheless, that though they are the composition of those who are beginning the race of the irprofession, yet the prizes have been awarded by men whose favourable judgment, even veterans in science would be proud to acknowledge.

The delay of the publication of these Essays, is owing to their having been sent for insertion in the Provincial Medical and Surgical Transactions, soon after the 4th of last June, and their not being returned till late in January last: it would be unjust not to state that they were returned with the following flattering expression. "And I was desired to explain to you, that, although the members of the Council at Worcester considered the Papers as in the highest degree creditable to the writers, as well as to the School in which they were educated, they felt themselves under the necessity of declining to insert them, in consequence of their being of a nature unsuited to the plan and object of the Institution."

School of Medicine, June 4, 1833.

INTRODUCTION.

THE functions of the living body are divided by physiologists into two classes, those of vegetative and animal life. The former, both in animals and man, is, in every respect, analagous to the life of plants. All its functions are performed without consciousness or volition; and from the first moment of existence, until death, the organs of vegetative life act uninterruptedly with greater or less energy. The functions of animal life, on the contrary, are performed with consciousness, and the brute as well as man has the full power of exercising his will on the organs over which they preside. The first of these systems is the subject of the following Essay—The nervous system of organic, nutritive or automatic life; The "Nerf de la vie organique" of Bichat, "Nerf Trisplanchnique" of Chaussier, the intercostal of old anatomists, the ganglionic, and sympathetic nerve of modern writers.

Surrounded by difficulties of no ordinary nature, and involving arduous and patient investigation, the study of this system becomes a subject of the most lively interest both to the anatomist, physiologist, and pathologist; not only on account of its importance in the œconomy, and the functions over which it presides, but also from the various affections which either its impaired energy, or actual organic change may give rise to.

The functions of the other part of the nervous system present, for the most part, phenomena with which we are perfectly familiar; but this is not the case with the system of organic life. For though the discourses of Johnstone, the speculations of Willis, Vieusseus, Soemmering, Whytt, Bichat, Reil, Wutzer, and Gall—the researches of Lancisi, Vicq d' Azyr, Monro, Haase, Scarpa, Legallois, Bell, Brodie, and Lobstein have elucidated some of the wonders of its functions, much yet remains involved in great obscurity; and we must be contented to collect and analyse facts, and compare them one with another, as the only method by which we can draw proper inferences, and arrive at a general conclusion.

After alluding to the comparative anatomy and structure of

the ganglionic system, I shall describe the great sympathetic nerve with regard to its situation, course, branches, ganglia and plexuses. Next I shall consider the opinions of the old anatomists, and the doctrines of physiologists on this subject up to the present time: summing up with a short disquisition on the use of the nerve in the animal œconomy; and finally concluding with an enumeration of the anormal or morbid states, both functional and organic, which have been found in it, or may be referred to it.

ON THE ANATOMY, &c.

OF THE

GREAT SYMPATHETIC NERVE.

COMPARATIVE ANATOMY OF THE GREAT SYMPATHETIC.

Tracing the anatomy of the nervous system from the lowest grade of animal life, up to the chef d' œuvre of the creation, man, we shall find that as animals rise in the scale of beings, new organs and new functions are added to them; and, as indispensable to more perfect and complicated organization, additional nerves are given them, endowed with new sensibility and new powers.

Thus, in the Hydræ and various other Zöophytes, the body is an homogeneous mass, composed of a gelatinous substance, interspersed with numerous minute globules, composed probably of nervous matter. Proceeding further in the scale, we find the nervous system appearing under the form of a whitish thread-like ring, surrounding the commencement of the œsophagus. Such is its form in the asterias, sipunculi, and some of the holothuriæ, as was first pointed out by Cuvier; and the experiments subsequently instituted by Spix remove all doubt as to the fact, and therefore we must look here for the first rudiments of a nervous system.

In some of the higher grades of Zöophytes, in the actiniæ and asterias, Spix and Tiedemann have described several ganglia arranged around the base of the stomach, whence numerous branches radiate to the surrounding parts. In the ascidia gelatinosa, Meckel discovered one larger and two smaller ganglia situated between the stomach and gills.

In the Zöophytes and Molluscæ, the cerebral ganglion surrounding the œsophagus corresponds probably to the brain in the superior classes of animals. The numerous chain of ganglia found in the articulata, in the leech, earth-worm, ascaris, &c., were sup-

posed by Bichat, Ackermann, and *Reil to be analogus to the sympathetic system in man and the higher animals, considering those nerves which, in the former, convey sensation and volition to be the same system which, in the latter, we regard as impeding the power of the will, and being destitute of sensation. The opinions of Meckel, Cuvier, and Gall, who compare it to the cerebro-spinal system of vertebrated animals, are now generally received. It is, however, probable that the ganglia found in some of the lower animals, in the zoophytes, mollusca, and articulata, have a strong relation and affinity in the functions they subserve, to the ganglionic system in the higher grades; and so we are led to believe from analogy. But it is only in the four superior classes, in the fishes, amphibia, birds, and mammalia, that the sympathetic is recognized as a distinct and peculiar system, destined for the organs of vegetative life, and to form a general system for the medium of the mutual influence of the animal and organic spheres.

The sympathetic nerve in fishes is extremely slender, and almost entirely without ganglia. It is usually very difficult to discover it, and particularly to trace it towards the head. In the burbot, (gadus lota), however, it can be easily traced from one intervertebral nerve to the other, forming small ganglia, and giving off branches, and lastly terminating in the maxillary nerve at the base of the cranium.† It appears to be connected with the cerebral nerves by the fifth pair alone, and with all the spinal nerves.— One of the most remarkable circumstances, however, is, that, according to Desmoulins, the nerves of the sympathetic are much less intimately connected with the arteries in fishes than in the superior class of animals.‡

In amphibia, as well as fishes, this system has hitherto been but imperfectly examined. Cuvier found the sympathetic nerve in the mud tortoise, with distinct ganglia on each side of the vertebral column, connected by double filaments: in frogs it extends upwards as a delicate thread along the vertebral column, and uniting with the ganglion formed by the vagus at its exit from the cranium, terminates at the ganglion of the maxillary nerve.

In birds, the sympathetic is placed on each side of the vertebral column, and has a distinct ganglion on each vertebra, which gives off numerous twigs to the neighbouring vessels and viscera, and one to the spinal nerves. This chain of ganglia is most conspicuous in the neck, where it is lodged in the canal formed by the transverse processes of the cervical vertebræ on each side.¶

* Speaking of their identity, he says, "Systema gangliosum in nonnulis animalium generibus solum reperitur, in aliis una cum systemate cerebrali adest, quocum singulari quadam connexione conjungitur. Funis gangliosus vermium, tantum reproductionis causa viventium, nihil aliud est, si usum spectaveris, quam systema gangliosum singulari forma constructum."— Anteurieth Archiv. Book 7, p. 190.

† Carus, Comp. Anat., p. 246. ‡ Anatomie des Sys. Nerv. ¶ Carus, l. c.

In the mammalia, as in man, the cervical portion of this nerve no longer lies immediately upon the vertebral column, and the number of ganglia in that region does not correspond to the number of vertebræ. So few other important peculiarities are to be found in the remaining divisions, that a distinct investigation appears superfluous.

It was remarked by Meckel and Weber, that the sympathetic nerve and par vagum have a reciprocal relation to each other in all vertebrated animals: the sympathetic becoming gradually less developed as the animal is inferior in the scale; and the par vagum, on the contrary, increasing in an inverse ratio, and by degrees occupying the place, and probably carrying on the functions, of the sympathetic. Thus, for example, the portion which the nervus vagus sends to the viscera in man, is small compared to that which the sympathetic furnishes. In birds and reptiles especially, the great sympathetic is diminished, and the vagus proportionally increased; and in fishes the two nerves are very conspicuous, and equal in bulk to the spinal marrow. We have now to consider the developement of this nerve in the series of animals, and embryos of the superior mammifera.

Some writers consider the sympathetic, or its elements, to be the first part formed in the impregnated ova of all warm-blooded animals, and before, or simultaneously with, the heart and vascular system. This theory was advocated by Ackermann,* who thought that all the nerves were derived from the heart; the cardiac nerves expanding grudually into the plexuses of the great sympathetic, and these, accompanying the arterial branches, and passing up to the cranium, forming the brain. But the investigations of Meckel, Sir E. Home and others, founded on observations furnished by the embryo, and by analogy, support the doctrine of the prior existence of the spinal marrow to the brain, and of both these systems to the sympathetic. Such is the most probable theory, that the central is developed before the peripheric system. But still we have every reason to believe that the sympathetic, or its rudiments, appear prior to, or simultaneously with the organs for which it is peculiarly destined, viz., the heart and arteries, rendering them sen sible to the stimulus of the blood; and thus while animal life is inactive in the fœtal state, so organic life on the contrary, is in action as soon as organization commences.

In the fœtal state, the sympathetic nerve and its branches, with the exception of the semi-lunar ganglia, which are more slowly developed, appear more perfect and distinct comparatively speaking, than in adults. In the fœtus at the third month the trunk of the sympathetic is fully apparent: the superior cervical ganglion is well formed, $2\frac{1}{2}$ lines long, and $\frac{1}{2}$ line in thickness: at five

* De syst. nerv. primordiis. Heidelberg, 1813.

months the trunk is yet more distinct, and forms an uninterrupted cord from the head to the pelvis. The superior cervical ganglion increases in an equal ratio: at six months it is 5 lines long, and 1 broad, at seven, 8 lines long, and nearly 2 broad. The splanchnic nerves at the third month, appear under the form of very fine slender filaments: at the fifth month they are more distinct, and their roots perceptible, and their developement gradually increases.—About the fifth month the semi-lunar ganglia are seen, though small and very obscure: they are developed much more slowly than the other parts of this system, and even in the perfect fœtus are not fully evolved.* In monstrosities and acephalous fœtuses, provided they retain the human form in some degree, the sympathetic and its nerves are generally perfect in all their parts. As there is so distinct a difference in the commencement of animal and organic life, so their is an equal difference in their termination; animal life in natural death ceasing, while organic is yet in action. In the old man, brought "to the utmost bounds of physiology, to death without disease" who "meurt en detail" this difference is most apparent —the functions of animal life gradually cease, those of organic life remaining in full activity.

STRUCTURE OF THE GREAT SYMPATHETIC NERVE.

In examining the structure of this system, I shall consider successively the trunk, branches, ganglia, and plexuses of which it is composed; and endeavour to show that both in appearance, colour, and structure, it differs essentially from other parts of the nervous system.

We may divide the nerves which compose it into three classes; 1st, those which unite the ganglia together, or the trunk; 2nd, those which unite the ganglia to the spinal nerves; 3rd, those which are distributed from the ganglia to the different organs. The first and second set closely resemble each other, both in appearance and structure, and are composed like other nerves of fibrillæ with an investing neurilemma. But according to Bichat and Reil, the third set, passing from the ganglia to the different viscera, are essentially distinct from the preceding: they are soft, of a red colour, thin, and cineritious, and of an indeterminate gelatinous structure.† Emanating from the ganglia, and not from the trunk, they form a net-work round the arterial trunks, and pass with them to their most minute ramifications. The mode in which they surround and

* Lobstein. Weber.

† Scarpa and Lobstein consider them to be the same as the trunk.

accompany arteries is various: sometimes they merely attend the trunk without adhering to it, being separated by cellular membrane—they follow its course, but do not appear to anastomose with each other: others form as it were a new tunic round the artery, adhering intimately to it, and so intermixed that they might be mistaken for a real theca surrounding the vessel:* round the branches they form plexuses, and end in their tunics.

We can add nothing certain, regarding the distribution of nerves from this system to venous trunks. The branches of the vena portarum, the pulmonary and jugular veins, certainly receive twigs from it—but anatomists generally describe the ganglionic nerves as accompanying the arteries alone. The ganglia of the great sympathetic vary considerably in different subjects, both as to volume, figure, situation, and even existence, for important ganglia are sometimes entirely wanting. In form, they are generally roundish, occasionally elongated, sometimes triangular, as the lenticular or semilunar, as that which bears this name. Although unprovided with a bony covering analogous to that of the brain, they are from their deep situation not the less defended against the action of external bodies. They are invested by two coverings: the first consists of a fine elastic cellular membrane, by which they are united to the surrounding parts, and in which the vessels proceeding to the ganglia ramify: this sometimes contains a yellow gelatinous fluid, and frequently fatty matter. The second is more delicate and vascular, and adheres more closely to the ganglia, forming the proper investing membrane, and surrounding the nerves arising from them. Wutzer mentions a cluster of cells or vesicles which he found in this tissue, but was unable to determine their nature.†

When this, the proper tunic, is removed, a soft, juicy, yellow or grayish homogeneous substance occurs, lodged in the areolæ of a delicate cellular tissue, which fills up the intervals between the nervous filaments: it is described by Scarpa as "substantia quædam mollis atque succosa, coloris cinerei vel lutei, quæ inter fila nervorum alte locata large implet eorum intervalla."‡ This substance has been considered by many physiologists as analogous to the cortical substance of the brain; but the experiments of Bichat and Wutzer prove that it differs from it both in appearance and chemical properties. According to the latter author, ganglia differ from nerves in containing a larger proportion of gelatin, and yet more from cerebral matter in the excess of gelatin and albumen, and smaller proportion of fatty matter.¶ M. Lassaigne§ found the ganglia of a horse to consist of a large quantity of fibrine, of albumen, traces of fatty matter, and phosphate and carbonate of lime. Submitted to the action of acids, heat, and alcohol, after being drawn together, shrunk and hardened, they soften by degrees and

* Bichat, Anat. Gen. † De corp. hum. gang. fabrica atque usu.
‡ Annot. Anat. ¶ l. c. § Journal de Physiologie, t. 1.

ultimately diffuse. A very similar result is obtained by concoction. They resist putrefaction longer than other nerves, but are quickly converted into fat by maceration in water.

Divested of their coverings and of this pulpy substance, the trunk of the nerve laying aside its neurilemma, appears to divide into numberless series of minute branches, hardly perceptible to the naked eye, which pass in various and complicated directions, transversely, longitudinally, and obliquely, and form a plexiform or reticular structure, which gives off branches from all points.

Ganglia are plentifully supplied with blood-vessels from the neighbouring parts; the cervical from the carotid, thyroideal and pharyngeal: the superior thoracic by branches from the subclavian: the pelvic by the lumbar arteries, &c. These branches first ramify in the filamentous tissue, to which they give twigs, and then perforating the proper coat immediately subdivide into innumerable minute canals, the first order of which forms a vascular net work on the inside of the tunic, while the residual twigs penetrate and ramify in the pulpy substance of the ganglia. The veins follow a similar distribution.

A plexus properly speaking, is only an anastomosis between the branches of the same or different nerves. Those of the sympathetic are remarkable for their reddish or grayish colour, and peculiar softness: the filaments interweave with one another and form angles and plexuses of net work, imbedded in cellular membrane, and frequently with difficulty distinguished from it. Scarpa considered them both in structure and office nearly allied to ganglia: he says, "In plexibus, veluti in ganglüs, nervi ex pluribus locis, diversaque origine advenientes, sub initio uniuntur, in centro miscentur, ad exitum sæpe in numerosiora filamenta dispertiuntur." But, that a plexus is analogous to a ganglion, and destined for the same end, we cannot allow, though at present we have no means of disproving such a theory: they are infinitely more simple in structure than ganglions, and intended probably for a much less complicated use.*

* On the distinction between ganglion and plexus, see Wrisberg, Obs. An. de quinto pare Encephali, § 12, p. 14.

SECTION I.

ANATOMY OF THE GREAT SYMPATHETIC NERVE.

In the anatomical description of this system, I shall adopt the arrangement followed by Cloquet and most modern anatomists, and commence with ganglia of the head; viz., the ophthalmic, the spheno-palatine, the cavernous, the naso-palatine, and sub-maxillary.

Ophthalmic Ganglion—1st. Of the ophthalmic or lenticular ganglion. This is one of the smallest ganglia in the body. It varies in form, but is generally somewhat square, elongated from behind downwards, of a reddish gray colour, and imbedded in soft fatty matter. Placed on the external part of the optic nerve, its outer convex corresponds to the abductor oculi muscle, its inner concave rests against the optic nerve. By its posterior inferior angle it communicates by means of a short thick twig with the inferior branch of the common motor nerve of the eye; by its posterior superior angle with the nasal branch of the ophthalmic nerve, and this appears to be the medium of communication between the ganglion and the rest of the system. From the anterior angles two bundles of slender, flexuous, reddish coloured nerves are given off, from ten to sixteen or twenty in number, usually accompanied by two or three filaments from the nasal nerve which are distributed with them. The superior, and smaller fasciculus, at first divides into three branches, each of which bifurcates, and together produce six twigs, which, proceeding in a parallel direction, run on the upper part of the optic nerve to the back of the eye. The inferior fasciculus, situated beneath and a little to the outer side of the optic nerve, is formed of six, eight, or ten filaments, which, on arriving at the posterior part of the back of the eye, perforate separately and in an oblique direction, the sclerotic coat. In their passage between this membrane and the choroid, they run parallel to each other and become somewhat flattened, but do not give filaments to either tunic. Arriving at the ciliary ligament, each branch subdivides into two or three twigs, which are distributed to it and to the iris, and are lost in them. A solitary branch from the inferior fasciculus passes outwards, and freely anastomosing with filaments of the nasal nerve, is distributed to the sclerotic under the rectus externus muscle.

Spheno-palatine Ganglion—The 1st spheno-palatine, or Meckel's, ganglion, is a small triangular or cordiform reddish body, of variable size, deeply situated in the pterygo-maxillary fissure, externally to the spheno-palatine foramen, imbedded in adipose cellular tissue. It gives off from its circumference several branches.—Superiorly it is connected with the superior maxillary nerve by one or two short thick twigs, inferiorly, it furnishes three branches, the palatine nerves: the inferior branch of these, which is the largest, immediately enters the posterior palatine canal, having previously given off a nasal filament, which is distributed to the middle and inferior turbinated bones: the trunk then runs through the canal, and just before its exit from it gives off two branches; 1st., a second nasal twig, which passes through the palate bone, proceeds along the edge of the inferior turbinated bone, and looses itself on the ascending process of the superior maxillary bone: 2nd, a filament which passes to the velum palati.

The trunk then emerges from the canal, passes forwards under the arch of the palate, and separates into several twigs, the outer of which are the most numerous, and pass along the inner edge of the superior alveolar process, and are lost in the gums; the inner subdivide on the middle of the palate, and furnish filaments to mucous follicles: some also anastomose with filaments from the naso-palatine ganglion.

The other two branches arise behind the former, and are named the middle naso-palatine or guttural nerve* and the small palatine nerve.

The middle naso-palatine nerve descends along the posterior part of the pterygo-maxillary fissure, and entering its proper canal, emerges behind the hook of the pterygoid process, dividing into two filaments, one of which goes to the tonsil and velum palati, the other to the velum only.

The second, or small, palatine nerve, situated posteriorly to the former, descends at first between the pterygoideus externus muscle and superior maxillary bone, then between the latter and palate bone, and divides into filaments which are distributed to the tonsil, uvula, and follicles of the mouth.

The third, or inner branches, arising from the spheno-palatine ganglion, form the spheno-palatine nerves. They vary from three to five in number, and pass directly through the spheno-palatine foramen into the nasal fosa, being distributed between the periosteum and schneiderian membrane to the superior and inferior turbinated bones. One large branch, termed the naso-palatine nerve, after traversing the arch of the nasal fossa, passes to the septum,

* Cloquet.

and descending obliquely forwards, arrives at the upper opening of the anterior palatine canal, and there meeting with the nerve of the opposite side, forms a small ganglion, the naso-palatine of Cloquet. The naso-palatine nerve anastomoses with filaments from the dental nerve.

The last branch from the spheno-palatine ganglion, is the vidian, or pterygoid nerve: it arises from the posterior part of the ganglion, and passing horizontally backwards, sends two slender twigs to the membrane lining the sphenoidal sinus, and entering the pterygoid canal, passes along it and gives off ramifications to the septum nasi, membrane of the pharynx, and eustachian tube. On emerging from the canal, the vidian nerve passes through the foramen lacerum basis cranii anterius, and divides into a superior and inferior branch: the latter, distributed to the walls of the carotid artery anastomoses with filaments* which the superior cervical ganglion sends to the external motor of the eye, and cavernous ganglion. The superior or cranial twig enters the skull between the petrous portion of the temporal and sphenoid bones, and proceeding backwards and outwards over the upper surface of the former, between the laminæ of the dura mater, and covered by the inferior maxillary nerve, sends two very delicate twigs into the cavity of the tympanum, which anastomose with each other and also communicate with filaments from the superior cervical ganglion and glosso-pharyngeal nerve: it then passes through the foramen innominatum, into the aquaduct of Fallopius, where, according to Cloquet, it is applied upon, without anastomosing with the facial nerve.† Opposite the base of the pyramid of the tympanum, it penetrates that cavity by an aperture proper to it, winding upwards and outwards. After giving off a filament which anastomoses with a twig from the carotid plexus, it traverses the tympanum from behind, forwards, passing first under the incus, then between it and the handle of the malleus, to which it is closely applied. A little above the tensor tympani, its direction becomes horizontal, and increasing in size, it soon afterwards descends forwards, and issues at the fissura Glasseri with the tendon of the laxator tympani, under the name of corda tympani. It then passes downwards, inwards, and forwards, and is attached to the lingual branch of the inferior maxillary nerve, which it accompanies till it arrives opposite the submaxillary gland, where it leaves it to go to the ganglion of that name.‡

* Before Meckel examined the vidian nerve and unravelled its branches, anatomists at first considered that the sympathetic took its origin from the fifth pair alone: such was the opinion of Galen. Eustachius, Morgagni, and Santorinus thought that it communicated with the sixth pair, the external motor nerve, only. Meckel afterwards assigned to it an origin from both; and this is the opinion now generally adopted.

† M. Manec, however, thinks that it does not unite with the nerve merely to separate afterwards under the name of corda tympani: "My numerous dissections," he says, "have proved to me that the latter is a distinct branch of the facial, which differs entirely from the vidian by its volume, harder consistence, and colour, which is never inclining to red like the vidian."—(Analytical Anatomy.)

‡ The connection between the sympathetic and glosso-pharyngeal in the tympanum, was pointed out by Jacobson, (Acta regiæ societatis Hafinensis Medicæ, v. 5, p. 292), and afterwards confirmed by Cloquet and Ehrmann.

Sub-maxillary Ganglion—The sub-maxillary ganglion is placed upon the internal surface of the sub-maxillary gland, a little below the stylo-glossus muscle: its superior part receives two or three filaments from the lingual branch of the inferior maxillary nerve, several twigs pass from its anterior part to the lingual nerve, sub-lingual gland, and mucous membrane lining the mouth: the inferior part also sends filaments to the sub-maxillary glands, where it communicates with branches from the carotid plexus accompanying the sub-mental artery.

Naso-palatine Ganglion—The naso-palatine ganglion I have mentioned as having been discovered by Cloquet at the point of union between the spheno-palatine nerves situated at the upper opening of the anterior palatine canal. It is a small reddish spongy mass, of an ovoid form, the large extremity being directed upwards, immersed in adipose cellular tissue: the superior extremity receives the two naso-palatine twigs.* The inferior sends one or two filaments which pass to the arch of the palate, and anastomose with filaments of the great palatine nerve, and ramify in the mucous membrane.

Cavernous Ganglion—The last ganglion in the head is the cavernous. This is situated in the cavernous sinus of the dura mater: is of a reddish gray colour, of variable form and size, and frequently wanting. Situated at the outer side of the internal carotid artery, towards the middle of the sinus, it sends off numerous slender filaments to the external motor and ophthalmic nerves, and sometimes to the nasal nerve, thus forming a communication with the ophthalmic ganglion. By its inferior extremity it communicates with the ascending filaments of the superior cervical ganglion.†

Of the Cervical Ganglion.

1st Cervical Ganglion—The sympathetic emerging from the carotid canal swells out into the first cervical ganglion, called from its figure, olivary. It is of a grayish colour inclining to red, soft consistence, and variable as to size, sometimes being twenty lines in length, at others more than thirty; it generally, however, corresponds in extent to the transverse processes of the three first cervical vertebræ. It is deeply situated at the base of the skull, in a depression above, and a little behind, the angle of the lower jaw, at the upper and external part of the rectus capitis anticus major, at first covered by the internal carotid, but afterwards lying anteri-

* See page 16.

† Ribes has described a small ganglion situated on the anterior cerebral artery which sends filaments to the carotid plexus, and thus unites the two extremities of the nerve.

or and to the inner side of it. Having in front the glosso-pharyngeal nerve, and externally and a little behind it, the internal jugular vein, pneumogastric, and hypoglossal nerves. In some rare cases the nerve at its exit from the carotid canal divides into two ganglia, external and internal, connected together by small branches.* This ganglion sends off numerous branches, distinguished into superior, inferior, external, internal, and anterior.

Superior Filament—The 1st or superior filament, which is sometimes double, is soft and of a red colour, surrounds the carotid artery and passes with it into the carotid canal, where it divides and forms a plexus round the artery. From this plexus several branches are given off:—one (the pterygoid filament of Chaussier) anastomoses with a filament from the vidian nerve and is distributed to the pharynx: others ascend to the cavernous sinus and form a plexus, branches of which are united to the external motor of the eye, and to the cavernous ganglion when present. According to Cloquet, a very slender filament enters an aperture in the walls of the aquæduct of Fallopius, runs along the promontory of the tympanum, and anastomoses with a filament of the glosso pharyngeal nerve and a twig from the vidian. Another branch traverses the cavernous sinus, and joining the ophthalmic or nasal nerve, forms a communication between the cervical and ophthalmic ganglia. The other branches from this plexus accompany the minute ramifications of the carotid artery.†

Inferior Filament—The 2nd or inferior filament, long and slender, descends vertically, before the rectus capitis anticus major and longus colli muscles covered by the carotid artery, lying between the internal jugular vein and pneumogastric and hypoglossal nerves, to which it is connected by loose cellular tissue: opposite the sixth cervical vertebra it immerges into the middle cervical ganglion.—In its course it receives some long slender twigs from the third and fourth cervical nerves, and sends some still more slender to the œsophagus and neighbouring cellular membrane: one branch anastomoses with the superior laryngeal of the eighth pair and is especially distributed to the thyroid gland, and lastly it sends two or three branches into the thorax to the cardiac plexus.

External Filament—The 3rd or external filaments are numerous and pass across the rectus capitis muscle: the two superior branches join the plexus formed by the sub-occipital and first cervical nerves: the third which is the longest, bifurcates and communicates with the first, second, and third cervical nerves:‡ the fourth

* Lobstein, de nervi sympathetic secun. fabrica, usu et morbis, p. 4.

† Lobstein does not admit all these anastomoses: he has seen transparent gelatinous filaments uniting the sympathetic with the motor nerve and others, but has not been able by the aid of a microscope to discover in them the characters of nerves: he thinks they are merely cellular tissue elongated into filaments.

‡ The common trunk of each spinal nerve a short distance from the ganglion, gives off a branch, which is sometimes double, which passes to the neighbouring ganglion of the great sym-

filament generally proceeds from the intervening trunk, and is distributed to the scaleni muscles, also anastomosing with the third cervical.

Internal Filament—The 4th or internal filaments which are much smaller than the preceding, are distributed to the rectus capitis and longus colli muscles, and terminate in the larynx and pharynx. The superior branches anastomose with twigs from the glosso-pharyngeal and pneumogastric nerves, and from the pharyngeal plexus: the lower form numerous plexuses over the thyroid gland and muscles of the inferior hyöid region, and penetrate the thyroid and cricoid membranes into the larynx, and anastomose with the superior laryngeal and recurrent nerves.

Anterior Filament—The 5th or anterior filaments of the superior cervical ganglion are more numerous and stronger than the preceding, in structure red and pulpy, and almost pellucid, and have been termed the *nervi molles*. The superior branches, which are the shortest, anastomose with the facial, pneumogastric, and hypoglossal nerves at a little distance from their exit from the cranium. The inferior branches, in conjunction with the descending filaments of the glosso-pharyngeal nerve, form a plexus round the common carotid artery, constituting the common carotid plexus: other branches, joined by filaments from the facial and pneumogastric nerves, form a plexus round the external carotid, and accompany the thyroideal, pharyngeal, lingual, and external maxillary arteries to their minutest ramifications. The common carotid plexus sends twigs to the larynx, pharynx, and treachea: that of the facial artery sends branches to the sub-maxillary gland, and anastomoses with the lingual and hypoglossal nerves. One of the most considerable of the anterior branches forms the superior cardiac nerve, which I shall describe hereafter.

2nd Cervical Ganglion—The 2nd or middle cervical ganglion, termed the thyroid, is formed opposite the fifth or sixth cervical vertebra: it is placed on the longus colli muscle, behind the common carotid and pneumogastric nerve, about two lines above the inferior thyroideal artery: it is rounded or lenticular in shape, about six lines long and four broad, but frequently wanting. The filaments which it gives off are—

External Filament—1st an external, which perforates transversely the scalenus muscle, and anastomoses with the fifth or sixth cervical nerve.

Internal Filament—2nd. Of the internal, some accompa-

pathetic nerve, and thus forms the most intimate connection between the two systems. This communicating branch, at first bearing all the characters of a spinal nerve, arrived within ¼ of an inch of the sympathetic, assumes both the colour and structure of the latter nerve :it is impossible to say from which root of the spinal nerve this branch proceeds.

ny the inferior thyroideal artery, and form a plexus around it, the thyroid plexus: others pass to the thyroid gland, œsophagus, and trachea, and anastomose with the recurrent laryngeal nerve: other branches unite with the carotid plexus, and one with the phrenic nerve.

Anterior Filament—3rd. The anterior filaments are from one to three in number, and form the middle cardiac nerve.

Inferior Filament—4th. The inferior are more delicate and slender than the others, about five or six in number: they descend both before and behind the subclavian artery on the right side, and round the aorta on the left, and anastomose with branches from the last cervical ganglion.

3rd Cervical Ganglion—The third or last cervical ganglion is situated on the inner side of the vertebral artery, about nine lines from the subclavian, and a little below the transverse process of the seventh cervical vertebra: it is of a very irregular form, sometimes double, but generally semilunar or rounded.

Besides the ascending filaments which unite this to the middle ganglion, others penetrate the vertebral canal, forming a plexus round the vertebral artery, which in its course gives off a number of twigs to the inter-transversales colli muscle, and also branches which anastomose with the anterior filament of the sub-occipital nerve, and with each of the cervical nerves at their exit from the cervical foramina. Another branch passes upwards and outwards between the rectus capitis anticus major and longus colli muscles, to which it gives ramifications.

Inferior Filament—The inferior filament is formed by a larger branch, which is sometimes double, and surrounds the subclavian artery: it connects this ganglion to the first thoracic, and is known by the name of ansa Vieussenii.

Internal Filaments—The internal filaments are not very numerous: they pass to the longus colli muscle, pulmonary plexus, and arch of the aorta: some also join the recurrent laryngeal and phrenic nerves.

External Filament—The external branches are numerous and slender, and surround the subclavian artery and the branches which it sends to the muscles of the neck. They anastomose with the two or three inferior cervical and first dorsal nerves.

Anterior Filaments—The anterior filaments from the last cervical ganglion unite to form the inferior cardiac nerves.

We now proceed to the description of the cardiac nerves and plexus.

The nerves peculiarly destined for the heart, are divided into three classes—superior, middle, and inferior; and these anastomosing and interweaving with each other form the cardiac plexus.

Superior Cardiac Nerve—The superior or superficial cardiac nerve is formed on the right side, by four, five, or six filaments proceeding from the anterior part of the first cervical ganglion, or from the intervening trunk. The union of these branches forms a slender filament, which descends vertically along the neck, by the side of the trachea, exterior to the common carotid, covered by the trunk of the sympathetic nerve. In its passage it gives off branches to the pharyngeal plexus and inferior thyroideal artery, and anastomoses with branches of the pneumo gastric nerve: it also communicates with the descending filament of the hypoglossal nerve, gives ramifications to the pharynx, œsophagus, sterno-hyoid, and sterno-thyroid muscles, and, passing outwards, penetrates the thorax behind the subclavian vein, and divides into several branches which join twigs from the inferior cervical ganglion and recurrent laryngeal nerve. Sometimes it descends to the arch of the aorta, and is united to the middle cardiac nerve, but never passes directly to the heart itself. It generally extends lower down on the left side than on the right, and anastomoses with twigs from the inferior cardiac or pneumogastric nerves.

Middle Cardiac—The middle, or great cardiac nerve is formed by the anterior branches of the second cervical ganglion.—Five or six twigs coalesce at a short distance from the ganglion into two or three branches, and these afterwards into one trunk, which descends first by the side of the common carotid, then before the subclavian artery, anastomosing in its course with filaments from the pneumogastric and its recurrent branch, and then, between the arch of the aorta and bifurcation of the trachea, uniting with the inferior cardiac nerve to form the cardiac plexus.

Such is the disposition of the nerve on the right side: on the left it receives a principal branch from the inferior cervical ganglion. It passes obliquely forwards and downwards behind the subclavian artery, and joined to filaments from the middle cervical ganglion and pneumogastric nerve, terminates in the cardiac plexus.

Inferior Cardiac—The inferior cardiac nerve is composed of filaments arising from the anterior part of the inferior cervical ganglion, which, after forming a sort of plexus, unite into a large branch, which descends behind the subclavian artery, before the arteria innominata and arch of the aorta, anastomoses with the pneumogastric nerve, and, passing between the aorta and pulmonary artery, gains the cardiac plexus.

Cardiac Plexus—The cardiac plexus* is, as we have shown,

* Ganglion Cardiacum, *Wrisberg*. Ganglion Molle, *Scarpa*.

the common point of union between the above-mentioned cardiac nerves: it is of a greyish colour, transparent or gelatinous appearance, and soft consistence. Situated behind the arch of the aorta and bifurcation of the trachea, it extends from the division of the pulmonary artery to the origin of the innominata, and is the immediate source from which the heart receives its nerves.

Anterior Filament—The anterior filaments of this plexus are not very numerous, and are distributed to the anterior wall of the aorta: the posterior more numerous, pass to the pulmonary plexus, and the inferior, still more numerous and larger, pertain almost exclusively to the heart, on which they form the two coronary plexuses.

Inferior Filament—Some of these inferior filaments collected into a bundle, embrace the remains of the ductus arteriosus, and pass over the pulmonary artery at its division, and penetrate the lungs, accompanying the pulmonary vessels: other branches descend upon the pulmonary artery to the heart. A large twig descending along the left pulmonary artery gains the base of the heart near the origin of the posterior coronary artery, and there forms a plexus round it, the posterior coronary plexus, which also forms secondary round its various branches.

Anterior Conorary Plexus—The anterior coronary plexus, much smaller than the former, follows the course of the left inferior cardiac nerve, which belongs entirely to it. It is formed by filaments which pass between the aorta and pulmonary artery, some of which anastomose with the posterior coronary plexus, while others pass to the right auricle and fore part of the base of the heart, accompanying the anterior coronary artery in all its ramifications. The two plexuses anastomose freely, and are joined also by branches of the par vagum.*

Of the Thoracic Ganglia.

The thoracic ganglia, smaller and less distinct than the cervical, though of a more regular figure, are oblong or fusiform in shape, and of a dense firm consistence. They are situated on each side of the vertebral column, beneath the pleura, and between the transverse processes of the vertebræ, a little anterior to the head of each rib: they vary in number from eleven to twelve on each side.

* The relation which the nerves of the heart have with the muscular structure is an object of discussion with anatomists: some, and amongst them Behrends, deny that the muscular structure receives nerves from the sympathetic, pretending that the nerves are distributed to the vessels only: Scarpa, Muninks, Zerenner and others, declare that they are distributed to the muscular fibre in the same manner as nerves of animal life to voluntary muscles.

1st Thoracic—The 1st ganglion, which is the largest, is sometimes united to the last cervical, and is seldom more than 2 or 3 lines distant from it: it is situated on the outer side of the longus colli muscle, and, like most other ganglia, gives off external and internal branches, and is connected to the ganglion below by a strong trunk.

External Filament—The external filaments vary from one to four in number: they proceed upwards and outwards, and anastomose by one or more large red branches with the intercostal nerves, giving small twigs to the intercostal muscles. Another filament, which is smaller and white, passes from the ganglion to the trunk of the nerve.*

Internal Filament—The internal filaments are numerous, and their distribution variable: those from the five first thoracic ganglia are short and slender and pass towards the median line, joining the pulmonary plexus, and sending twigs to the œsophagus, thoracic duct, aorta, vena azygos, vertebral column, and intercostal muscles.†

But from the inner part of the sixth to the tenth or sometimes eleventh thoracic ganglia, three, four, or five‡ branches are formed, which, passing obliquely from above downwards, and from without inwards, coalesce opposite the tenth dorsal vertebra into one large trunk, the great splanchnic nerve: it then passes between the crura of the diaphragm¶ from the chest into the abdomen, behind the stomach and a little above the renal capsule, and separating into three or four branches is lost in the semilunar ganglion.

Lesser Splanchnic—The lesser splanchnic nerve is formed by one or two filaments derived from the eleventh and twelve thoracic ganglia which pass through an opening in the crura of the diaphragm, exterior to the great splanchnic, and distribute twigs to the renal plexus and semi-lunar ganglion: it also gives two small branches to the thoracic duct and receptaculum chyli, and others to the crura of the diaphragm and intercostal muscles.

The tenth thoracic ganglion gives off a long filament separate from the splanchnic nerve, which passes downwards and forwards to the fore part of the aorta, and accompanies it into the abdomen, terminating in the cœliac plexus.§

* Manec, Analytical Anatomy.—Great Symp. Nerve.

† Wrisberg, Cloquet, Lobstein. ‡ Wrisberg mentions from three to eight branches.

¶ And sometimes, according to Meckel, through the same opening with the aorta. Manuel d' Anat., t. 3., p. 140.

§ Cloquet, Lobstein.

Of the Semi-lunar Ganglion and Solar Plexus.

Semi-lunar Ganglion—The great splanchnic nerve having penetrated the crura of the diaphragm into the abdomen forms a large ganglion on each side, called the semi-lunar. The first description of this ganglion was given by Vieussens, who terms it the "cerebrum abdominale;" and by Meckel and others it is considered to be the centre of the ganglionic system. In form they are semi-lunar, though subject to great variety, about 1 inch long, and ½ inch broad, their convex border looking outwards, their concave inwards. The ganglion on the right side is generally larger than the left, and is placed near the head of the pancreas, between the vena cava and right crus of the diaphragm on one side, and the right renal artery and superior extremity of the supra-renal capsule on the other. The left ganglion is situated between the left pillar of the diaphragm, pancreas, splenic artery, and left sur-renal capsule. Several nervous nodules are sometimes found instead of the ganglia, joined together by branches: in a case described by Wrisberg* it formed a net-work containing eleven small ganglia.

Solar Plexus—From the periphery of the two semi-lunar ganglia, a vast mass of filaments proceed, connecting them together, and this anastomosis joined by branches of the vagus and phrenic nerves, constitutes the solar plexus. It is placed before the abdominal aorta, behind the peritoneum, between the two sur-renal capsules, concealed by the stomach anteriorly, by the liver and diaphragm above, and pancreas below. From this great solar plexus spring as many secondary plexuses as the aorta gives off branches from its anterior and lateral parts; consequently, there is a sub-diaphragmatic, a cœliac, a superior mesenteric, an inferior mesenteric, a renal or emulgent, and a spermatic plexus.

Diaphragmatic Plexus—The sub-diaphragmatic plexus is formed by several threads which proceed from the upper part of the solar plexus, and anastomosing with the phrenic plexus, ascend on the crura of the diaphragm with the inferior diaphragmatic artery, and terminate in its muscular fibre.

Cœliac Plexus—The cœliac plexus surrounds the cœliac artery, and, like it, divides into three plexuses, the coronary, hepatic, and splenic.

Coronary Plexus—1st. The coronary plexus passes from below upwards, and accompanying the coronary artery along the small curve of the stomach, spreads over its two surfaces, and anastomoses frequently with the pneumogastric and the hepatic plexus.

Hepatic Plexus—2nd. The hepatic plexus, much larger

* Wrisberg, de nervis viscerum abdominalium, p. 34

than the preceding, passing to the fissure of the liver, divides above the pylorus into two portions: the inferior accompanies the gastrica epiploica dextra along the great curve of the stomach, and sends numerous filaments to that viscus, to the pancreas, and duodenum: the superior, which is the largest, joins the hepatic vessels, and passes with them into the substance of the liver. Branches also surround the neck of the gall-bladder and ductus communis choledochus. The hepatic plexus receives numerous filaments from the pneumogastric nerve.

Splenic Plexus—3rd. The splenic plexus is composed of two branches; one from the right stomachic, the other from the left semilunar ganglion. They surround the splenic artery, and when at the fissure of the spleen give two twigs to each arterial branch, and ultimately mingle themselves with the parenchymatous substance of the organ.

Superior Mesenteric Plexus—The superior mesenteric plexus surrounds the superior mesenteric artery, and appears to be the inferior continuation of the solar plexus. It descends with the artery between the pancreas and transverse portion of the duodenum, to which it gives branches, and passing between the laminæ of the mesentery, forms numerous plexuses interspersed with ganglia, and accompanies the ramifications of the artery over the whole surface of the small intestines, the cœcum, and beginning of the transverse colon.

Inferior Mesenteric Plexus—The inferior mesenteric plexus gives off a small number of threads, which descend on the left side of the spinal column, and, anastomosing with branches from the lumbar ganglia and renal plexus, form the inferior mesenteric plexus. It accompanies and closely invests the inferior mesenteric artery, and enters with it the iliac meso-colon. Branches pass with the mesenteric artery to the meso-rectum, and one accompanies the iliac and hypogastric arteries.

Renal Plexus—The upper part of the semilunar ganglion gives off four or five branches on each side, which together with filaments from the superior mesenteric plexus, from the last dorsal, first, and sometimes second, lumbar nerves, and lesser splanchnic, form the renal plexus: this surrounds the emulgent artery, and passes with it into the substance of the kidney. Lobstein* says that no branches are given to the renal veins, or to the pelvis of the kidney, though a branch may be seen accompanying the ureter and ending in its tunics.

Supra Renal Plexus—At the commencement of the supra renal arteries, five or six filaments are given off from the renal

* Lobstein, l. c.

plexus, semilunar ganglion, and diaphragmatic plexus, which form a secondary plexus, which accompanies the supra-renal artery, and penetrates the capsulæ renales, termed the supra renal plexus.

Spermatic Plexus—The spermatic plexus is formed by three or four branches from the renal plexus united to some filaments from the superior mesenteric, or aortic plexus. It descends with the spermatic vessels to the testicle in the male, and to the ovarium and fallopian tubes in the female, and probably penetrates the tissues of these organs.†

Lumbar Ganglia—We now revert to the trunk of the great sympathetic. Having formed the solar plexus, it descends on the sides of the lumbar vertebræ, slightly converging towards the median line, and forms four or five oblong ganglia on each side, placed on the anterior edge of the psoas magnus, covered on the right side by the vena cava, on the left by the aorta. The connecting filaments are longer and more numerous than in the thorax, being generally three or four in number. Each ganglion gives off from its outer side two or three long thick branches, which pass between the fibres of the psoas muscle, to meet the anterior branches of the lumbar nerves. Those of the upper ganglia pass obliquely upwards, the middle transversely, and the inferior obliquely downwards—small twigs are given off to the psoas, pyramidalis, and levator ani muscles.

Internal Filaments—The internal filaments, numerous and slender, pass downwards and inwards to the abdominal aorta, round which they form a minute net-work, the aortic plexus, or mesenteric of Vieussens. Numerous filaments from the splenic, hepatic, renal, spermatic, and mesenteric plexuses, also pass to it.—It gives off a few threads to the iliac and hypogastric arteries and their branches. This plexus then descends upon the body of the fifth lumbar vertebra into the pelvis, and forms the greatest part of the hypogastric plexus.

Sacral Ganglia—The sacral ganglia, three or four on each side, occupy the lateral part of the anterior face of the sacrum. placed near or upon the foramina. The first communicates with the last lumbar ganglion; the last gives off one or more filaments, which, passing inwards to the sacro-coccygeal ligament, unite with each other, and generally form a small ganglion from which some twigs are given off to the ischio-coccygean muscles, levator and sphincter ani.

External Filaments—The external filaments of the sacral ganglia communicate with the anterior branches of the sacral nerves, and give twigs to the pyramidalis and levator ani muscles.

† An inferior spermatic plexus is mentioned by Walter, which is formed chiefly by filaments from the trunk of the great sympathetic, and sends no proper branches to the spermatic vessels. Lobstein and Manec have never found it.

Internal Filaments.—The internal spread themselves upon the anterior surface of the sacrum, on which they form a plexus, and anastomose with each other. The anterior branches, joined by filaments from the vesical, hæmorrhoidal, sacral, and, in the female, vaginal and uterine nerves, together with branches from the inferior mesenteric and aortic plexus, form the hypogastric plexus. It lies upon the sacral plexus, pyramidalis muscle, and hypogastric vessels, and contains several small ganglia. The nerves arising from it are distributed to the rectum, ureter, bladder, vesiculæ seminales, and prostate gland in the male, uterus and vagina in females.*

SECTION II

PHYSIOLOGY OF THE GREAT SYMPATHETIC NERVE.

Previous to the end of the seventeenth century the physiology of the great sympathetic nerve remained altogether unexplained. The ancient anatomists indeed appear to have endeavoured to ascertain its existence rather than its functions, and from the time of Galen to that of Willis no hints worthy of record were advanced respecting it. From the time of Willis (1676) however, the works of German, French, Italian, and English physiologists abound in speculative, and in many instances absurd theories as to its use.—In this section I shall briefly review in their order the most important writers on this subject, and finally, state the probable functions of the ganglia as deduced from the most rational and generally received opinions.

If we investigate the writings of the old physicians we shall find few records in them of the use of the ganglia: Hippocrates in his book περὶ φλεβῶν mentions the intercostal nerve, but does not refer to the ganglia found on it: the first notice of them is certainly given by Galen (A. D. 193) in his sixteenth book "De usu parti-

* Lobstein hes never been able to detect nerves entering the substance of the uterus, either in the impregnated state or not.

um." He considered them as placed on the course of nerves for the purpose of strengthening them.*

After Galen, Fallopius and Eustachius wrote on this subject, but we are indebted to Willis (A. D. 1676) for a more elaborate anatomical description of it, and the first distinction between the sympathetic and par vagum. He considered the sympathetic nerve as connecting the conceptions of the brain, and affections of the præcordia, and the actions and passions of almost all parts of the body the functions of which are involuntary: the ganglia he considered as knots similar to those in the roots of trees;† as diverticula (in quibus diverticulum concederetur spiritibus) preparing or modifying in some manner that peculiar principle which the ancient physiologists supposed to be produced, elaborated, and circulated in the nervous system, which they termed animal or vital spirits.

A. D. 1684.—Vieussens after Willis considered the intercostal nerve as the medium of that great sympathy which exists between the brain and viscera, the different affections of the brain not only influencing the viscera, but those of the viscera affecting the brain or destroying life itself. He describes the ganglia, or gangliform plexuses, as he terms them, as composed of nervous fibrils, arteries and veins, invested by a firm membrane, in which the powers of the animal spirits are nourished and preserved by the influx of arterial blood.‡ He supposed them to be the seat of a fermentation caused by the circulation of impure blood, abounding in "acrid juices," by which convulsive motion is excited in the muscular fibre.¶

Lancisi, Vicq d' Azyr, and Gorter compared the ganglia with the heart, and supposed them to be provided with muscular fibres, capable by their contraction of accelerating and impelling the active principle of the nerves. The former thought that they resembled muscular fibre both in colour and structure, and were placed on the course of nerves for the same purpose as conglobate glands on lymphatic vessels.||

A. D. 1730.—The first idea thrown out as to the separate and

* "Est autem et aliud mirabile naturæ opus ab anatomicis ignoratum: ubi enim aut longo itinere nervum est ductura exiguum, aut motui musculi vehementi ministraturum, ibi substantia ejus corpore crassiori quidem, cætera autem simile intercipit. Dices enim nervum esse conglobatum: primo quidem aspectu ipsis adnatus esse videtur, ac circumhærens: si tamen dissecueris, apparet evidentur, quod neque adnatus est, neque circumhæret; sed apparet similis quædam nervis substantia continua ac undequaque unita, ac omnino nervo similis, qui tum ad ipsam pervenit, tum rursus ex ipsa porrigit."

† "Ejusmodi vero plexuum usus videtur esse idem qui est nodorum in caudice arboris, seu qualis diverticuli est juxta compita siti; nempe ut cum spiritus animales una cum succo nervoso itinera diversa instituant, ne mutuo occursantes confunderentur, alii ab aliis secedere, et donec ordines suos et justam diataxin recuperent, paululum divertere possint."—Willis, Cerebri Anat. 1676, p. 120.

‡ Neur. Universalis, p. 190.

¶ The Stahlians considered the motions of the heart to be continued and regulated by the soul, acting as a wise and rational agent with a view to the good of the body.—Whytt on the vital and other involuntary motions of animals, note, p. 431.

|| Morgagni, adversaria anat. xxxiv.

independent function of the sympathetic, was, I believe, by Winslow, who, in his Anatomy says, that the ganglia may be looked upon as so many origins or germina dispersed through this great pair of nerves, and consequently as so many little brains.*

A. D. 1749.—Meckel considered the use of the ganglia to be, 1st, to multiply the nervous ramifications, and render them more delicate, for on entering them, the nerves, abandoning their neurilemma, are reduced to their constituent filaments, and on issuing from them, are re-invested by a new envelope. 2nd. To facilitate the distribution of nerves to different organs. 3rd. To re-unite the branches of the same or different nerves into one cord.†

A. D. 1753.—This theory was also supported by Zina, who adds, that in ganglia the nerves become intimately mixed, while in plexuses, the branches are only laid together, and do not interweave with each other. "Je crois," says he, "qu' une utilitié des ganglions qui n' est pas à mèpriser, c'est que les fibres nerveuses qui cerrivent par divers troucs, s'y mêlent d' une mainère nitime, cequi n' aurait pas pu se faire avec autant de facilitè dans des plexus nerveaux."‡

Alexander Monro after speaking of their structure, confesses "that of their use we are entirely ignorant."

A. D. 1764.—In the year 1764, thirty-five years previous to Bichat's works, Johnstone first published his theory of the ganglia in the Philosophical Transactions, and in 1771 in a separate essay.¶ He pronounced the ganglia to be composed of a cineritious and medullary matter, furnished with numerous minute vessels and nervous fibres, capable of evolving nervous matter, analogous to the brain in their office, subordinate springs and reservoirs of nervous power, and capable of dispensing it long after all communication with the brain is cut off: "In a word" he says, "ganglia limit the exercise of the soul's authority in the animal œconomy, and put it out of our power by a single volition to stop the motions of the heart, and in one capricious instant irrecoverably to end our lives." He concluded that they are the instruments by which the motions of the heart and intestines are from the earliest to the latest periods of animal life rendered uniformly involuntary. "When we consider that the nerves which are more immediately ministerial to the soul, and convey impressions of external objects to it, have no ganglions; that they are never found upon the olfactory, optic or auditory

* P. 94., sec. 364.

† Meckel, Obs. Anat. Sur un nœud ou ganglion du second rameau de la cinquieme paire des nerfs du cerveau, nouvellement decouvert avec l'examen physiologique du veritable usage des gang. des nerfs.—Mem. de l'Acad. de Berlin, 1749, p. 85.

‡ Histoire de l' Acad. Royale, An 1753.

¶ An Essay on the use of the ganglions of the nerves, by James Johnstone, M. D. Shrewsbury, 1771.

nerves, and that they are as rare upon the nerves instrumental to voluntary motion, as they are constant and numerous in parts whose motions are independent of our volitions, we have the firmest grounds of belief that ganglia on the latter are placed as checks to the powers of volition."*

A. D. 1772—Before Johnstone's doctrine of the Ganglions appeared in the Phil. Trans., Lancisi,† Winslow,‡ Gorter,¶ Le Cat,§ Tarin,|| Meckel,** and Zinn†† had promulgated different opinions on this subject; but Haase wrote his Treatise on the Ganglia afterwards, and assigned to them an office merely mechanical, stating their use to be that the nerves might diverge in them, and changing their direction, disperse to different parts. He thought the pulpy substance of the ganglia analogous to, and fulfilling the office of cellular membrane.‡‡ He denies that they facilitate the distribution of vessels to nerves, or that their use is to unite the branches of nerves.

A. D. 1778—Tissot first uniquivocally admitted the doctrines of Johnstone. "M. Johnstone, célébre Médecin Anglois, s'en est occupé dans un ouvrage fort bien-fait; son systême est très ingenieux, et mérite d'ètre connu. Il part d'un principe très vrai, déjà indiqué plus haut; pour parvenir, dit-il, à la connoissance des ganglions, examinons quelles sont les fonctions et les caractéres des parties auxquelles se distribuent les nerfs qui en partent; et en faisant cet examen, il trouve que ce sont celles dont les mouvemens sont absolument indépendans de la volonté, et dont les fonctions sont les plus importantes dans la machine humaine, le cœur et les viscéres abdominaux; cette indépendance dans les mouvemens ne dépendant point des fibres musculaires qui paroissent de même nature dans ces parties que dans les autres, elle ne peut dépendre que des nerfs; mais ces nerfs n'ont de caractere distinctif que les ganglions; ne peut-on donc pas en conclure, *que les ganglions sont l'organe dont la nature se sert pour rendre le mouvement du cœur et des intestins absolument indépendant de la volonté.*"¶¶ &c.

A. D. 1779—Scarpa, agreeing with the opinions of Meckel and Zinn, imputes a triple use to the ganglia; viz., that of separating, mixing, and again collecting the nervous branches. He compares the intimate arrangement of the filaments in a ganglion to a rope, the component threads of which are untwisted and teased out at any particular point.§§

* l. c., p. 22.

† Diss. Epistolaris—Romæ, 1718. Morgagni, Adversaria Anatomica, No. 5, p. 110.

‡ Traite des Nerfs, t 2, sec. 364, p. 595. ¶ Chirurgia repurgata, sec. 799 et seq.

§ Dis sur la sensibilite, etc., art. 3. || L'Encyclopædie Fr, Au mot Ganglion.

** Memoires de Berlin, Pour 1749. †† Idem, Pour 1753.

‡‡ Primus gangliorum usus est ut nervuli in iis a se recedant. Alia gangliorum utilitas est ut nervi mutata directione ad proximas variis e regionibus positas partes dividantur.—De Gang. Nervor., Leip., 1772. ¶¶ Traite des Nerfs, &c., tome i., pt. ii., p. 133.

§§ Nervorum trunci, vel radices, apicem superiorem ganglii ingredientes, incipiunt dissociar. Segregati autem, ac in plurima fila soluti, corpus ganglii latius efficiunt, atque iterum collecti ad apicem inferiorem ex eo in novos truncos coacervati egrediuntur.—Scarpa, Annot. Anat., vii. 1779.

A. D. 1801—The first who took up, and assumed *to himself,* the theory established by Johnstone, was Bichat, according to whom the whole system ascribed to organic or nutritive life, is nothing but a congeries of insulated centres independent of each other, from which the different organs receive nervous energy. The anatomical difference between organic and animal nerves, he defines to be this—that the latter have a common centre, the brain; the former, many centres, the ganglia: these are connected together by the intervention of branches, and what is termed the trunk is merely an anastomosis, or series of nervous communications, and not as is generally supposed, a nerve proceeding from the brain or spinal cord.¶

He adduces the following arguments to prove that it is not a nerve of the same description as others, but only a series of anastomoses: 1st. That the communications are frequently interrupted, without any effect on the organs supplied: thus, he says, a distinct interval is in some instances observed between the pectoral and lumbar portion of this nerve. (Weber, Portal, and Lobstein, however, affirm that they never saw it interrupted in its course, though on superficial examination it sometimes does appear so.) 2nd. That the opthalmic and spheno-palatine ganglia are constantly found in an insulated state, and that they communicate by means of their branches with the cerebral nerves only. 3rd. That in birds, as Cuvier has ascertained, the superior cervical ganglion is always found insulated, never communicating with the inferior. The investigations of Tiedemann,* Emmert,† and Meckel,‡ however, prove that this idea is incorrect, that in birds there always does exist a communication with the 1st cervical ganglion.

This theory was improved upon by Reil,¶ according to whom, the sympathetic nerve constitutes a system totally different from the cerebral. It belongs only to organs of nutrition, presides over function alone, and by its assistance things lost and consumed by the process of life are re-produced, wherefore it is rightly called the nervous vegetative system. In the more perfect classes of animals, it is intimately connected with the cerebral or animal nervous system, but yet in no degree is it produced or emanates from it. The cerebral and ganglionic systems essentially differ from each other: 1st, in the branches of the former running to the brain, and there becoming rooted, which is therefore the central system: 2nd, in the ganglia having no one focus of action, but being widely diffused. He considers the use of this great series or chain of ganglia to be the following—1st, that the power of the will on internal organs and those pertaining to animal life may be lessened. 2nd, that the "pathemata" or internal impressions which the vital pro-

* Bichat, Anatomie Generale. Translated by Constant Coffyn, v. i, p. 241.

† Zoologie, b. 2, p. 44. ‡ Archiv. fur die Physiologie, b. 11, p. 117.

¶ Manuel d' Anat., t. 1, p. 256. ‖ Archiv. fur die Physiologie, p. 189.

cess is constantly evolving, may be restrained within their proper sphere, and not be transmitted to the brain. Thus, if there existed no cervical or thoracic ganglia, if the cardiac nerves proceeded directly from the spinal or cerebral, the heart would be under the power of the will, like other voluntary muscles: and, if nature had placed no ganglia between the abdominal plexus and spinalis, the irritation which food might excite in the viscera would extend to the brain. Ganglia, he says, appear to be analogous to insulated bodies in electricity. In the animal circle determinations of the will are generally carried to the sensorium. In the ganglionic circle the nervous energy is slowly and obscurely developed. In the healthy state he thinks the ganglionic exerts no manifest influence on the cerebral, but that it is otherwise in disease, when its action becomes changed, and impressions received in the viscera are transmitted to the brain.*

A. D. 1815.—Wilson Philip while reiterating, yet controverting the experiments of Legallois, considers the ganglia as reservoirs of nervous influence, receiving supplies from all parts of the brain and spinal cord, and conveying to certain organs the energy derived from both. Their powers, he says, are independent of both, yet subjected to the influence of every part of both, communicated through the medium of the ganglions.† He grants that Bichat derived his Theory from Johnstone.

A. D. 1817.—The opinion of Johnstone adopted by Reil, that the ganglia are nervous centres, was supported by Wutzer,‡ who endeavoured to corroborate their theories by new arguments and experiments. The ganglia, he thinks, diminish and impair the action of the brain and spinal marrow on the nerves connected to them, and, under certain conditions, entirely destroy it: in the same way they intercept the transmission of sensations to the animal sphere.

But probably the most essential support of this opinion is derived from Lobstein,¶ who not only admitted but defended it.—"Johnstone avoit pensé que les entrelacemens et les ganglions nerveux avoient pour usage de soustraire les nerfs qui en sortoient à l'empire de la volonté; mais les objections de Haller contre ce système ingénieux avoient paru sans réplique, ou au moins personne n' avoit répliqué. M. Lobstein y répondit, aprés s'être assuré par la dissection que les ganglions ophthalmique et sphénopalatin ne fournissoint immediatement aucun rameau aux parties musculaires, et en montrant d'ailleurs comment de légères exceptions à la loi établie par Johnstone ne suffiroient pas pour la détruire."‖

* l c., p. 190-2.

† An Experimental enquiry into the laws of the vital functions: and Edin. Med. & Surg. Journal

‡ De corp. hum. gang. fabrica atque usu.—Berlin, 1817

¶ Lobsteins Inquiries into the Anatomy and Functions of the Nervous system were much extended afterwards, and were published in a posthumous work—J. F. Lobstein, de nervi symp. humani fabrica, usu et morbis.—4*to*., Paris, 1823.

Vicq-d'Azyr Ouvres, tome iii, p. 48. and vide autograph of a letter from Baron Haller, in Ap.

Many experiments have been performed by physiologists to endeavour to explore the functions and vital principle of the ganglionic system. Johnstone long since proved that though dependent upon the brain and spinal cord it is not immediately so: in his experiments upon animals he found that irritation and even destruction of the spinal cord had not the least effect upon the heart or viscera, while violent convulsions were caused in the animal nerves.

Bichat, Wutzer, Lobstein, and others, have irritated the ganglia both mechanically and chemically without the animal evincing any sign of pain. Bichat, in his experiments on dogs, found that they continued alive and expressed not the least sign of agitation on the semilunar ganglia being violently irritated, though on touching a spinal or cerebral nerve, the dog cried, struggled, and attempted to rise.* These experiments were afterwards authenticated by Reil and others. Dupuy,† in his experiments on living horses, excised the cervical ganglion in four cases: he describes it as being easily done, exciting little pain, and not causing any immediate effect, but after a time giving rise to contraction of the pupil, suffusion of the conjunctiva, universal wasting, and œdema of the limbs.

Wutzer‡ irritated the lumbar ganglia in various ways in dogs, without any subsequent effect: galvanism however, he says, excited violent convulsions. Lobstein¶ afterwards tried the effect of galvanism on the sympathetic nerve of a fœtus almost dead from the skull being broken in, and the brain allowed to escape in a bad labour, but without any phenomena following. Weber seems to think that if the plate touches the nerve alone, no effect is produced on the muscles to which it belongs, though, if applied to the muscles and nerves some effect does take place, and still greater if to the muscles alone.||

These experiments, together with several which I have repeated, prove that the sympathetic, though perhaps not actually destitute of sensibility, is yet much below other parts of the nervous system in this particular. Division of the nerve in different parts of its course, has been followed by results hardly more satisfactory. Brodie divided the vagus and sympathetic on both sides in a dog, and injected a solution of arsenic into the stomach, which rapidly excites secretion: on killing the animal he found the villous coat of the stomach inflamed, but no abundance of gastric juice.

From the situation of the nerves, and the unavoidable irritation which arises from long-continued experiments on animals, it is difficult, perhaps impossible, to demonstrate satisfactorily the influence of this system on digestion, circulation, absorption, and secre-

* Anat. Generale, t. 1. † Bulletin de la societe d' emulation. Paris, 1816

‡ De nerv. symp. hum. gang. fabrica atque usu.—p. 127. ¶ l. c., p. 99.

|| Anat. Comparata nervi symp.—p. 130

tion, functions over which it especially presides. It was attempted by Philip, but his accuracy is controverted by Brodie, Broughton, and Majendie.

The experiments of Sir E. Home on the influence of these nerves on arteries, will be alluded to in the latter part of this section.

From this brief survey, we may arrange the opinions of authors on the use and functions of the ganglia, under two divisions: in one a purely mechanical use is assigned them, viz., that of facilitating the distribution of nerves, and favouring their re-union and separation: such was the opinion of Meckel, Zinn, Haase, Scarpa, and Legallois. In the other, functions essentially vital are attributed to them; they are considered as so many nervous centres, small brains, "subordinate springs, and reservoirs of nervous power," destined to moderate, or even destroy, the reciprocal influence between the brain and nerves: this was obscurely hinted at by Winslow, but belongs truly to Johnstone, and was afterwards adopted by Unzer, Metzger, Bichat, Reil, Wutzer, Lobstein, and most modern physiologists.

From the history of this system in the different classes of animals, we see that its developement decreases as the animal is inferior in the scale: thus, while in man and the mammalia it is preeminent, in birds and reptiles it is less apparent, and in fishes hardly distinguishable. We constantly find that it is developed in inverse ratio to the par vagum; as the sympathetic increases, the vagus proportionally decreasing, and vice versâ; so that in some classes the vagus alone appears to carry on the functions of animal life. Indeed, the relation between the two nerves appear to be so intimate, both in man and the inferior animals, that it is difficult to state the actual difference between them. The par vagum we know is nearly as extensive in its distribution as the sympathetic; it gives branches to the œsophagus, larynx, pharynx, vessels of the neck and heart, lungs, liver, spleen, stomach, and duodenum, and sometimes to the diaphragm.

Both anatomical and physiological arguments support the supposition that the sympathetic forms a separate and peculiar system in the animal economy, not directly dependent either upon the brain or spinal cord, though intimately connected with both, and endowed with certain and defined functions. The ganglia themselves we may regard as dispersed centres of nervous influence, which diminish and modify, and under certain conditions, even destroy, the action of the brain and spinal cord on the organs of animal life; and in the same manner they prevent the sensations created in the viscera from being conveyed to the animal sphere. We see that this system presides over organs and functions purely involuntary. Thus food taken into the stomach undergoes the

various processes of digestion uninteruptedly and uninfluenced by the will; the blood, agitated by the alternate action of the heart and arteries, carries nutriment to all parts of the body; the various secretions go on in one unvaried and constant train; the mind has no knowledge of these processes, receives no irritation from them, and in like manner exerts no power over them; it cannot for a single moment suspend the action of the heart, the digestion of food, or the function of any one vital organ.

The mechanism by which the sympathetic exercises these different powers and functions, we are as ignorant of as we are of the actual functions of the brain. Although we acknowledge that nerves are the media of sensation and volition, we are utterly at a loss to account for the manner in which the nervous influence is propagated. Vibration, a nervous fluid, electricity, and galvanism have each in their turn had their supporters. But while we recognize the effect, the final cause remains veiled in impenetrable obscurity; and it remains for future philosophers to discover the intimate mechanism both of the organic and animal spheres, and to establish as science what at present is merely visionary hypothesis and idle conjecture.

The two great processes over which the sympathetic presides in a remarkable manner, are digestion and the circulation of the blood; and consequently upon secretion, absorption and nutrition.

The influence which it has over the circulating system is proved both by its developement, and by direct experiment. Tiedemann has shown that the heart in fishes is much less developed, comparatively speaking, than in birds and the mammalia; and this same occurrence takes place, as we have seen, with regard to the sympathetic—the vascular system decreasing both in size and perfection in the inferior animals, and the ganglionic system becoming more simple and less developed in an equal ratio. The experiments of Johnstone, Legallois, and others, prove that the motion of the heart is independent of the cerebro-spinal system, and that it can be supported without either brain or spinal cord: it is by the sympathetic, therefore, that it is regulated, and through its agency is the blood distributed to the different parts of the body, and the various processes of secretion and nutrition performed. The experiments of Sir E. Home on the action of the arteries confirm this opinion. The par vagum and sympathetic in a dog (where they form one bundle) were laid bare, and touched with the kali purum; it caused the carotid artery to pulsate with great violence, but in a few minutes it returned to its natural state. In a rabbit, where the par vagum alone was irritated, no change whatever took place in the artery.*

* Philosophical Transactions, 1814.

Accompanying the branches of the arteries in all their most minute ramifications, into the very tissues of the different organs, the sympathetic in like manner presides over the various secretions. Branches of it have been traced to the ductus communis choledochus, ureter, and vas deferens; and we may hence infer that they are present in the secretory vessels of conglomerate and conglobate glands. It influences in a special manner the secretion of saliva, bile, pancreatic and gastric juice, semen, urine, and probably the catamenial discharge in the female.

Finally, the sympathetic presides over all the actions of the abdominal organs, of the stomach, intestines, liver, spleen, kidneys, genital system, &c. It associates with them all, and by its anastomoses with the par vagum, is the medium of sympathy between the head and abdomen. Thus the presence of worms in the intestinal canal produces grinding of the teeth, and disordered bowels dimness of sight, head-ache, and convulsive affections; calculi in the kidney, sickness; and hence we are so often puzzled by anomalous symptoms when the head and the organs belonging to it seem disordered by those functional affections which obviously pertain to the organs of digestion: and versâ vice, when sickness, vomiting, and those affections which generally belong to the system of primary digestion, are produced by wounds or diseases of the brain.

SECTION III.

PATHOLOGY OF THE GREAT SYMPATHETIC NERVE.

When treating of the physiolygy of this nerve we have shown that its sensibility, in its normal state, is much below that of any other part of the nervous system: it is probable, however, that in the morbid condition this is considerably increased, and that it is the seat of many of that numerous class of affections in which the abdomen and chest, but particularly the former, appear to be the centre from whence they proceed. In reviewing the pathology of this system, I shall 1st consider the organic lesions which have been discovered in it, and 2ndly, its functional affections: those dis

cases in which the powers and energy of the ganglionic system are involved, which may probably at last induce alteration of structure.

The anormal appearance most generally met with in the ganglia and their nerves is inflammation. I have often, says M. Andral, examined them carefully in individuals who have died of various diseases, and have but in two instances discovered any alteration in them, and that was merely a strong redness in the semilunar ganglia. In both instances there had been ataxic symptoms during life, and in one the patient died in a state of tetanus.*

Lobstein,† who has made great research in the pathology of the sympathetic, mentions several curious cases in which inflammation was discovered. The first, a woman who had long suffered from head-ache and hypochondriasis, accompanied for three months with constant vomiting, whose symptoms were aggravated by gestation: she died of marasmus. On examination after death the stomach and all the viscera were healthy, but the semilunar ganglia, though not changed in structure, were of a deep red colour and highly inflamed; this appearance remained though the part was macerated in water for three days. He considers this to have been a chronic affection of the nerves aggravated by pregnancy.

In the case of a girl‡ who had hooping cough, which changed by metastasis into spasmodic vomiting for three days, and then into convulsions, the left solar plexus was alone inflamed. Anteurieth in a similar case, found inflammation of the par vagum together with the sympathetic and cardiac nerves.¶

Lobstein also mentions other cases in which the ganglia were inflamed: in one, the patient was affected with trismus and opisthotonos: in another, the ninth and tenth thoracic ganglia were red and inflamed after the retrocession of an exanthematous disease. In a woman who died of pulmonary hectic, the right cardiac nerves were swelled, red and soft.§

Mr. Swan, in his experiments on animals, found the ganglia and nerves of the sympathetic inflamed and, in some instances, thickened, after affecting the system with mercury, whether exhibited by the mouth, or injected into the veins. He thinks that it has a specific influence on this system, producing first irritation and afterwards inflammation. In a man who died of tetanus, he found the sympathetic nerves in the chest, and also the semi-lunar ganglia more vascular than usual, and slightly enlarged. He thinks it difficult to determine whether this appearance was the effect of the medicine he had taken, (spirit of turpentine, and calomel and

* Anat. Pathol. † l. c.

‡ l. c., p. 150. ¶ Beclard, Anat. Genera e, p. 647. § l. c., p. 152.

opium), or connected with the disease.* I have, however, seen the upper thoracic ganglia much more vascular than usual in a case of tetanus in which calomel was not exhibited.

In these various cases, the lesion consisted chiefly in hyperæmia of the ganglia or their nerves. I shall now proceed to those cases in which structural change is recorded.

Dr. Schiffner, of Vienna, in the case of a Cretin, æt. 33, in whom the inferior maxillary, portio dura of the 7th and 8th pair, and most of the spinal nerves, were affected with swellings as large as peas, found the ganglia of the sympathetic much increased in size. Opposite the 6th cervical vertebra on the left side, there was a ganglion as large as a hen's egg flattened.†. M. Cayre, in his thesis on idiotism, states that he observed the ganglionic system preternaturally developed in a case of congenital idiotcy, the cervical ganglia being three times as large as natural, and the thoracic and semilunar much increased in size.‡

M. Cruveilhier, in his "Anatomie Pathologique," has given a plate and description of organic alteration, and unusual developement of the cervical ganglia and trunk of the sympathetic. The largest (the 1st) was two inches and three lines long and one inch in diameter, and from the upper part a sort of accessory ganglion was appended, of a smaller size, but dense and cartilaginous in structure: it pressed upon the eustachian tube, and would probably interrupt the passage of air into the tympanum. The larger ganglia were of a dense fibrous structure, and greyish white colour.—On making a section of the tumour, "il cria sous le scalpel," and appeared very similar to the prostate gland: the nervous substance did not present any excess of nutrition. These appearances were discovered in a subject in the dissecting-room, and whether they were the cause of death or functional disorder, is a question which cannot be solved.¶

Dr Duncan, in the dissection of a case of diabetes in the Edinburgh Infirmary, says, "The sympathetic on both sides from its entrance through the diaphragm into the cavity of the abdomen, to its descent into the pelvis, was enlarged to about three or four times its natural size, and there was an increase in the size of the splanchnic nerve on both sides to the same extent, from about two inches within the cavity of the chest, until it perforated the diaphragm.‖

Lobstein has seen the supra-renal plexus much larger than na-

* An Inquiry into the action of Mercury on the living Body, p. 11.

† Archives de Medicine, t. 2. ‡ Andral, Patholog. Anat., v. 2, p. 807.

¶ 1re. Livraison. "Maladies des nerfs ganglionnaires."

‖ Reports of the practice in the clinical wards of the Edinburgh Infirmary.—p. 134

tural in an individual in whom the renal capsules themselves had acquired increased bulk and become tuberculous; but in this, as in the other cases, it is impossible to determine which is the primary disease.

Bichat frequently examined the ganglia in diseases of the viscera, without detecting any change in them. In the worst cases of cancer of the stomach, he has constantly found the semilunar ganglia uninjured, except in one case, where its volume was increased, and its substance rather more dense than natural.

In a subject brought to the Hotel Dieu for madness, he found the semilunar ganglion the size of a filbert, and containing a small cartilaginous body in the centre.*

The only instance in which I have found structure in this system, was in a case of chronic abdominal inflammation, attended with constant diarrhœa: the patient was reduced to a state of marasmus, and appeared to die from inanition. The peritoneum lining the abdominal cavity, was in a state of chronic inflammation, and a copious effusion of lymph had taken place, agglutinating the intestines and mesentery into one solid mass: the ganglionic system in the abdomen was unusually developed: the ganglia were considerably enlarged, lobulated, of a yellowish colour, and rather firmer consistence than usual: the trunk and branches were natural.

Functional Diseases of the Ganglia.

Physicians long since suspected that the ganglionic system of nerves, was chiefly affected in several nervous abdominal diseases, especially in hysteria and hypochondriasis: this is now established as a pathological fact, and they are referred to simple neuralgia of these nerves. As far back as the time of Vieussens, we see that convulsions of muscular parts, and spasms of nerves, as he calls them, were referred to this system, to a fermentation in the ganglia caused by "foreign and fermented juices meeting and mingling with the animal spirits."†

Bichat considered hysteria to be an affection of the semilunar ganglion and solar plexus: he has, however, examined two subjects who were frequently affected during life, with hysterical fits, without finding any morbid alteration: it appears more probably, to be

* Anatomie Generale.

† "Maxime probabili conjectura inferre liceat partium musculis, vel fibris muscularibus instructarum convulsiones, motusque convulsivos, quemadmodum et nervorum corrugationes, saltem ut plurimum, a fermentationibus peudere quæ in ganglioformibus nervorum plexibus, ab occursu heterogeneorum succorum primum excitantur, totique illorum tractui protinus communicantur."—Neurographia Universalis, p. 190.

an affection of the uterine nervous system, affecting by sympathy the epigastric organs, especially the respiratory system, thus inducing difficulty of breathing, constriction of the larynx, and violent convulsions. The symptoms marking both the hysterical habit and hysterical paroxysm, the general irritability, the causeless dread of impending evil, dyspepsia in all its forms, the globus hystericus, peculiar secretion of urine, and the sympathetic affection of the head, all clearly indicate some peculiar irritation of the abdominal nervous system.

Melancholy, mania, and that lighter shade of it hypochondriasis, although affections as yet involved in too much obscurity to warrant any decided opinion either as regards their seat or nature, are most probably materially connected with, and dependent on, that wonderful sympathy which exists between the brain and system of ganglia: except in the case mentioned by M. Cayre, I know of no record of their being found diseased in any cerebral affection.

There is another class of diseases which must be referred to neuralgia, perhaps in some instances to an inflammatory condition of the organic nerves, viz., the different colics, essentially nervous, and independent of all local affection, at all events inflammatory affection, either of the serous, mucous, or muscular structure of the intestines. Dehaen* and M. Merat,† in the examination of those who died of lead colic, found only simple constriction in some parts of the large intestines, sometimes in the colon. M. Andral‡ found no lesion whatever in the cases he examined. Dehaen first, and Merat and Andral subsequently, have placed the seat of lead colic in the great sympathetic, affecting particularly the abdominal plexus.

Some writers, and amongst them Lobstein, have referred various other diseases in which the functions of the abdominal or thoracic are impaired, to functional disorder of this system: as hooping-cough to the cœliac plexus, augina pectoris to the cardiac plexus, and perhaps pulmonary nerves. Daily experience proves to us that head-ache, convulsive affections, and even delirium, in some cases amaurosis, dilated pupil, and nyctalopia, frequently arise from visceral obstruction or irritation, but these are cases which prove the intimate sympathy existing between the organic and sensitive systems, rather than any thing else; and I believe there are no pathological facts on record to prove that the sympathetic is affected in any other way.

Lobstein, in his "Traité d' Anatomie Pathologique," mentions an affection of the solar plexus which he terms paralysis, or "abépithymie." It is of this paralysis of the solar plexus, he says, that

* De Colica pictonum, Hayæ 1745. † Dissertation sur la colique metallique, Paris, 1804.
‡ Clinique Medicale, t. 4.

persons die who are seized with sudden emotions of the mind, as terror or anger, or when they perish from indigestion, or from a blow on the epigastrium, in fact, from any great commotion in the abdominal nerves, whether from moral or physical causes: this state was also observed by Ruysch, but no manifest lesion has been discovered in them, and the immediate cause of death remains unexplained: we constantly, however, see that in the nervous system of animal life various kinds of convulsions, epilepsy, tetanus, &c., take place without any structural change being found in it: the same occurs without doubt in the organic system, and we have reason to believe that the nerves of the thoracic and abdominal viscera may be affected in the same manner without any sensible morbid signs.

How far fever depends on ganglionic influence, we have so few facts to guide our inferences, that it remains for us only to theorise. The phœnomena of fever are chiefly those of the circulating system, either depression or excitement, although in fevers of contagion or poison, the cerebro-spinal and ganglionic systems are both disordered. Nevertheless, if we were to consider the circulating system as chiefly influenced by fever, even then ganglions, the plexuses, and the ganglionic nerves always accompanying blood-vessels in their course, must be materially concerned. Whatever it be that causes the cold stage of fever, *something* stops or impedes the capillary circulation, causing rigors, coldness, and the partially cyanose appearance, which in its greatest degree, and when it nearly clogs the whole circulation, characterises the new fever called "Cholera Asiatica." Loder, of Moscow, first called the attention of the medical profession to the pathology of this system in cholera, and M. Delpech of Montpelier, has subsequently confirmed his statements, and given several cases in which the ganglia were found inflamed and otherwise diseased. The semilunar ganglia and solar plexus were the portions most generally affected, and he found their neurilemma infiltrated by a matter of a "rosy tint, shining, hard, and solid when cut into." The semilunar ganglia were voluminous, red, and injected, their section shining and moist.* Subsequent investigations have thrown some doubt upon the above statement, but from the symptoms attending the disease, the manifest effects on circulation and secretion, and the absence of any morbid appearances in these systems to account for such effects, we have every reason to suspect that the system of organic life is materially implicated in it—But what is **LIFE!**

Pains in the back it is well known give notice of many internal diseases, and accompany many of the natural functions of the body. The only notice of some diseases of the kidneys is pain in the loins; subscapular pains indicate hepatic affections, and pain in the lumbar regions is one of the characteristic signs of eruption about to take place in febrile disorders, and in a greater or less degree attends all

* Cholera Gazette, No. 4.

fevers. The contractions of the uterus in parturition, are at first only designated by pains of the back, and these pains are the main trouble inflicted by nature on the female in bringing forth children: how are we account for these pains but through the interlacement of the ganglionic with the cerebro-spinal system?

Many things in the preceding pages will, I have no doubt, be liable to just criticism, but the subject itself must be my apology.—I have treated the anatomical section, by far the most tangible part, as clearly and succintly as its nature will allow: regarding its physiology I have broached no new theory, assumed no fresh discovery, but preferred stating facts, supported by experiment and analogy, to speculations on the functions of a system which, to use the words of Bell, "we know only by its negatives." Its pathology, unillumed by physiology, has made but little progress towards perfection; the few facts which we possess, however, are valuable as laying the foundation for a more extended and perfect superstructure. We must remember that no science is perfect—and what is defective is not to be rejected as illusory or totally false: for (to use the words of the illustrious discoverer), "In the first gleams of light, and the first conceptions of truth itself on subjects that border on human knowledge, difficulties will abound; and the darkness which terminates our prospect, must necessarily cloud and obscure its confines."*

* Johnstone, on Ganglions of the Nerves, p. 62.

The following letter of Baron Haller offers the only objection of that great Physiologist to the Johnstonian Theory—an objection fully refuted by Lobstein. I have the gratification of adding it to this Essay, through the kindness of Dr. John Johnstone, as its COLOPHON.

April 30, 1832.

Baron Haller to Dr Johnstone Senr

Sir my Sorry ye hurry of ye departing occasion forces me to be So very short. I'v Seen your Thoughts on ye nerves and their ganglions in ye Philos Transactions, and for any thing I know there is but one objection, ye ophthalmic ganglion, who lies entirely between nerves, dedicated to voluntary motion.

I Shall look for some opportunity to show You my great regard and am allways, all yours

Haller 21 maj 1769 Bern